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(71)(72) Applicant and Inventor: KIVIMAA, Eero [FI/FI]; Linnankoskenkatu 15 A, FIN-00250 Helsinki (FI).

(72) Inventor; and

(75) Inventor/Applicant *(for US only)*: KIVIMAA, Antti [FI/FI]; Asematie 22 A, FIN-02700 Kauniainen (FI).

(74) Agent: OY KOLSTER AB; Iso Roobertinkatu 23, P.O. Box 148, FIN-00121 Helsinki (FI).

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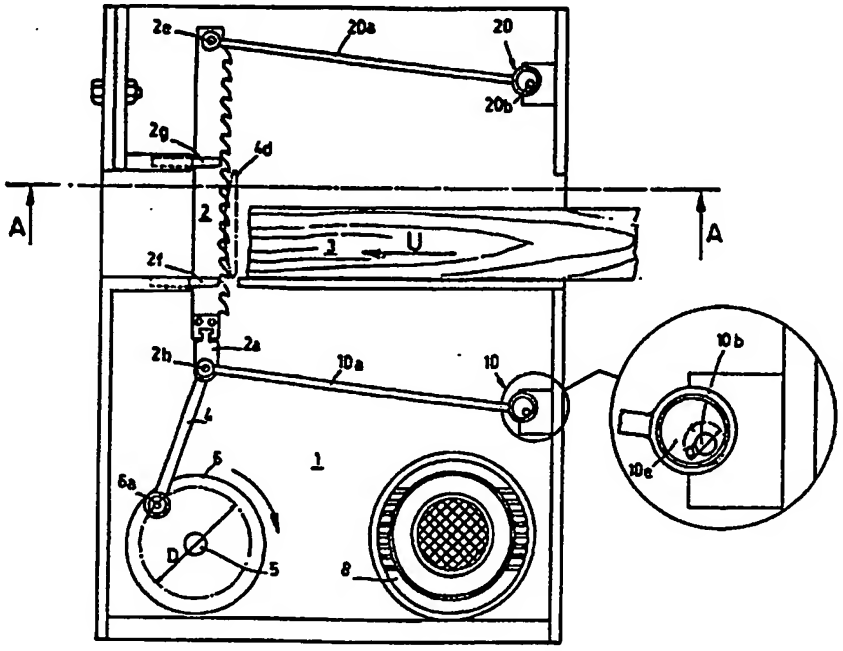
(54) Title: SAWING MACHINE



(57) Abstract

The invention relates to a sawing machine having a blade set reciprocating in the direction of the blades (2) and means (20) for effecting a transverse yielding movement of the blades. The speed of the blades (2) can be increased if the yielding movement is effected by an eccentric element (20c) connected to the end of the blade set via a connecting rod (20a).

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Sawing machine

The invention relates to a sawing machine having a blade set comprising at least one elongated blade and blade fixing means to which the ends of the blade are fixed, means attached to one end of the blade set for reciprocating the blade set essentially lengthwise of the blade, and means attached to at least one end of the blade set to produce a yielding movement of the blade essentially perpendicularly to the longitudinal direction of the blade, said means being formed from a connecting rod, one end of which is attached to the blade set, and from an eccentric element.

The background of the invention is traceable to the applicant's investigations conducted on gang saws in the 1950's. The investigations showed that the blades were subjected to great power peaks caused by the fact that the teeth on the blades had to 'cut' with their backs at the start of a return stroke. This in high-power gang saws (stroke length 700 mm) required a stretching force of about 80000 N per blade, a mass of about 600 kg for the reciprocating parts, and a small stroke number, about 350 1/min.

First was developed a 'lever saw', in which a sufficient blade stretching force was about 1/20 of the above. Tests performed with three laboratory test saws and one industrial prototype (stroke length 500 mm and stroke number 470 1/min) showed promising results. The drawback of the lever saw was its complicated structure, which prevented serial production of the machine.

Background art is also represented by a gang saw disclosed in EP 0,412,958, the saw comprising means, a connecting rod and an eccentric element for

producing a linear reciprocating sawing movement. The end of the connecting rod spaced apart from the blades is mounted via two rods on the frame of the machine and on the eccentric, respectively.

The object of the present invention is to provide a sawing machine having a simple structure and blades that perform highly advantageous sawing movement. The sawing machine of the invention is characterized in that the other end of the connecting rod is connected to the eccentric element, the rate of rotation of the element being synchronized with the lengthwise movement of the blade so as to make the blade move along an essentially elliptic path in the sawing region.

When the end of the connecting rod is connected directly to the eccentric element, the path of the blade becomes essentially elliptic, which is highly advantageous to the sawing result.

During the research, the structure of a sawing machine according to the invention has been successfully developed by scale model technology, which has helped to simplify the structure of the machine and eliminate a large number of 'unnecessary' moving parts.

Research and development have resulted in a sawing method having the following main characteristics:

- the teeth on the blade have an advantageous elliptic cutting path, which is essentially straight (or slightly curved toward the feed direction) during the working stroke of the blades, rounded at the dead points of the reciprocating movement of the blade, and curved backward during the return stroke;

- a reciprocating sawing movement is effected with a drive connecting rod connected to one (lower) end of the blades or blade set;

- in the cutting plane of the blades, the cutting path of the teeth is effected with a control connecting rod, the eccentric movement of which is synchronized with the drive crank wheel of the machine;

- in the cutting plane, the blade set is supported with wide control rods and with blade guides located above and below the timber to be cut;

- the blade set is assembled with assembly bolts passing through blades, spacers and end pieces;

- stretching of blades and a blade frame have been eliminated altogether.

A preferred embodiment of the invention is characterized in that the control connecting rods are connected to both ends of the blade means.

A sawing machine according to the invention is illustrated by the following schematic drawings. The simple means for feeding and controlling the timber to be sawn are not shown in the drawings, nor is the adjustment of the overhang of the blades, since they are not the object of the present invention.

Fig. 1 shows a first embodiment of a sawing machine of the invention, seen from the left-hand side in the direction of feed of the timber;

fig. 2 shows a reduced view of the sawing machine from the opposite side;

fig. 3 is a cross-section taken along line A-A of fig. 1;

fig. 4 shows an enlarged front view of a blade set;

fig. 5 shows a side view of the blade set;

fig. 6 shows an enlarged view of the cutting path 4d of the teeth in the middle section of the blade;

fig. 7 shows a second embodiment of a sawing machine of the invention, seen from the left-hand side in the direction of feed of the timber, like fig. 1;

fig. 8 shows an enlarged cross-sectional view of a spring means; and

fig. 9 shows an enlarged view of a cutting path 4d2 of the teeth in the middle section of the blade.

The cutting path of the teeth on the blades is drawn with a model machine constructed in the scale 1:2 of the planned prototype saw with a stroke length of 300 mm and stroke number of 1200-1500 1/min.

In the figures, a frame of the machine is indicated by reference number 1. Number 2 indicates a blade or a blade set comprising blades, and 2a indicates a blade beam on which a blade set assembled from blades 2, spacers 2b separating them and end pieces 2c is arranged with assembly bolts 2d and an assembly shaft 2e. The fit between the blades 2 and the shaft 2e is rendered so wide in the longitudinal direction of the blades that minor unequal heat expansion of a blade can take place without obstruction. The blades are guided in the lateral direction by a guide unit 2f from beneath the timber to be sawn and by a movable guide unit 2g from above.

Reference number 3 indicates timber to be sawn, the timber being fed at a feed speed u against the blades moving back and forth essentially vertically. The blades are moved by a connecting rod 4, the rod being mounted on a shaft 2h fixed to a blade beam 2a such that it articulates. The drive connecting rod 4 is moved via a crank 6a by a crank wheel and thereby a flywheel 6 fixed to the shaft, the crank wheel being driven by a drive wheel 7 arranged on the same shaft on the other side of the frame 1 and mounted

on the frame, the drive wheel in turn being connected with a band 7a to a driving device 8, preferably an electric motor controlled by a frequency converter.

A control rod 10a of a lower control system 10 is also mounted on the shaft 2h, the rod also being the connecting rod of the system and obtaining the minor control movement from an eccentric element 10e fixed to a crank shaft 10b and mounted on the control connecting rod 10a. The control connecting rod 10a is essentially perpendicular to the longitudinal direction of the blades. The control connecting rod of the upper end of the blade set is, in turn, mounted on the assembly shaft 2e of the blade set. Toothed wheels 10c and 20c fixed to shafts 10b and 20b are moved synchronously via a toothed belt 7d by a pulley 7c of an equal size, the pulley being connected to the drive shaft of the machine and the belt being supported by a tension roller 7e.

By the joint effect of the control of the lower and upper ends of the blades, an advantageous cutting path 4d of the teeth (fig. 1) in the middle of the blades is obtained, the advantageous path approximating an ellipsis, fig. 6. As regards the path, during a downward working stroke of the blade, the path is essentially straight; when the blades are at a lower dead point, the path is rounded; during a return stroke of the blades, the path curves backward and the blade is detached from the bottom of the saw kerf; when the blades are at an upper dead point, the path is rounded.

In the figure, D indicates the diameter of the path of the crank 6a in the drive crank wheel 6 and the stroke length of the blades. Reference d, in turn, indicates the diameter of the crank movement of the control system 10, the diameter here being equal to the corresponding diameter in control system 20.

The advantageous cutting path found in the investigations was examined with simple test equipment and a power-driven model saw having a stroke length of 150 mm. The shape of the path has been noted to depend on the ratio of the stroke length D of the blades to the length of the control connecting rods - in the test, the ratio was 1:2.5 and 1:3 - and on the diameter d of the control rod, which in the above model saw is 18 mm. The shape of the cutting path can also be affected by changing the synchronization of the drive and control connecting rods of the machine.

During research, it has become clearer and clearer that blades need not be stretched and that a blade frame is unnecessary. This has also been studied by means of calculations. The most critical point seemed to be the stability of the blade at the end of a working stroke (= at the beginning of a return stroke), at which point the blade is subjected, in the longitudinal direction, to compression stress caused by inertia forces and possibly exceeding the buckling limit. The risk, however, is smaller than expected for the following reasons:

- When a blade set is made in the above manner so that a blade is pressed at both ends and on both sides by plane surfaces, this corresponds to the fourth Euler stress case known in the mechanics of materials: 'both ends of a rod (= blade) are fixed and are on the original axis', whereby the risk of buckling is minimal.

- As the rotation speed increases, the time during which buckling is possible is minimized. The Euler formulae are obviously based on the results of slow static load. The present dynamic stroke-like loading method may surpass the static buckling limit even to a great extent.

- The thickness of the blade affects the sturdiness of the blade in the power of three, so the blade can be easily made more rigid by making it thicker.

Due to the blade guides and the expedient path of the blades, the sawing machine according to the invention is able to operate without the blades being stretched in the longitudinal direction by a blade frame or by some other system. When the machine is in operation, the blades are subjected to inertia and cutting forces in the longitudinal direction. The stretching of blades that compensates for these forces can be implemented, where necessary, by spring means, the spring force of which generates a reaction force to the inertia forces of the blade and its fixing arrangements during the operation of the machine when the blade is located at and in the vicinity of the dead point of the path on the side of the connecting rod of the crank wheel. Because of this, the buckling risk of the blades is decreased or removed, and it is possible to use very thin blades in the machine, which in turn enables sawing of very thin boards and sheets.

In the investigation of the spring means, the suitability of helical springs, diaphragm springs and torsion bars was examined. All the spring solutions mentioned are, in principle, possible, but according to the investigations it was preferable to use a cylinder connected to the frame of a sawing machine and a piston moving therein, the piston rod of the piston being connected to a blade fixing arrangement. A spring means like this is preferred especially because its simple and versatile adjustment possibilities.

A second embodiment of the sawing machine according to the invention, comprising the above-described spring means, is shown in figures 7 to 9.

In this embodiment of the sawing machine, the lower end of the blade set in the cutting plane of the blades is controlled by control rods of a straight movement component 40 arranged below the feeding table of the machine and connected to shaft 2h. This kind of straight movement is known from the Applicant's own patent FI 77,397. The control of the upper end of the blade set is implemented by a crank-connecting-rod-control component 20 according to the invention. By a joint effect of such control of the lower and upper blade ends, the teeth in the middle of the blades (fig. 7) obtain a preferred, elliptic cutting path 4d2, fig. 9, which is narrower than the path 4d in the first embodiment.

The spring means 30 shown in figures 7 and 8 comprises: a cylinder 31, a piston 32 moving inside it as well as a piston rod 33, an abutment ring 35 surrounding a cylinder pipe 31, the ring having two shaft journals 36 articulated to a support 37 fixed to the frame 1 of the machine on both sides of the pipe 31. The piston rod 33 passes through a linear slide bearing 38 arranged at the lower end of the pipe 31 and is articulated at its lower end to shaft 2e at the upper end of the blade means.

When the machine is in operation, the drive connecting rod 4 pulls with the blades 2 and the piston rod 33 the piston 32 downward, the increasing atmospheric pressure stretches the blades, and the tensile stress directed to the blades is maintained positive all the time, which stabilizes the operation of the blades and enables the use of very thin blades. The cylinder 31 has holes through which air can change. The maximum force directed to the piston 32 depends on the diameter of the piston and on the compression ratio h:h1 of the cylinder, in which h is the distance of the

lower surface of the holes in the cylinder from the bottom of the cylinder and h1 is the smallest distance of the piston. The compression ratio can be changed by adjusting the length of the piston rod 33.

When a new sawing machine according to the invention is compared with a conventional gang saw the study of which launched the development of a new sawing machine over 40 years ago, the following matters are noted:

The new sawing machine is small, simple in structure and clear and rapid in operation, since the mass of the reciprocating parts of the machine is, due to the advantageous path of the teeth on the blade, only 1 to 2% of that of a conventional gang saw having the same sawing capacity. Since the mobile parts are light, the machine is not difficult to balance. Also, the thin blades are small, simple and easy to maintain; they are well laterally supported at their both ends in the blade set that is assembled outside the machine and can be changed rapidly, the support being helped with blade guides. The system makes it possible to saw very thin boards. The number of the blades sawing simultaneously can also be selected very freely. The higher cutting speed and the blade guides make it possible to obtain thin chips (sawdust), a good sawing result and good timber measuring accuracy. Because of the thin blades and the good measuring accuracy, the new sawing machine makes it possible to produce products from the same raw material with a smaller loss of raw material, whereby the sawing is significantly more economic.

It is possible that the new sawing machine will replace the conventional gang saw due to its above advantages and also take up fields of use from band saws and circular saws, especially in sawing of logs.

Since the new sawing machine cannot be defined to belong to any previously known type of sawing machine, its working title has been an ellipse saw due to the cutting path of the teeth on the blade that approximates an ellipse.

Claims

1. A sawing machine having

a blade set comprising at least one elongated blade (2) and blade fixing means to which the ends of the blade are fixed,

means (4, 6, 8) attached to one end of the blade set for reciprocating the blade set essentially lengthwise of the blade, and

means (10, 20) attached to at least one end of the blade set to produce a yielding movement of the blade (2) essentially perpendicularly to the longitudinal direction of the blade, said means being formed from a connecting rod (10a, 20a), one end of which is attached to the blade set, and from an eccentric element (10e, 20e), c h a r a c t e r i z e d in that the other end of the connecting rod (10a, 20a) is connected to the eccentric element (10e, 20e), the rate of rotation of the element being synchronized with the lengthwise movement of the blade so as to make the blade (2) move along an essentially elliptic path (4d) in the sawing region.

2. A sawing machine according to claim 1, c h a r a c t e r i z e d in that the means (20) that produce the yielding movement of the blade (2) are attached to that end of the blade set which is spaced apart from the end to which the means (4, 6, 8) for moving the blade set are attached, and that to the last-mentioned end of the blade set are attached means (40) for effecting straight movement of the blade.

3. A sawing machine according to claim 1 or 2, c h a r a c t e r i z e d in that the means (4, 6, 8) moving the blade set and the means (10; 40) effecting the yielding movement or straight movement of the blade

are attached to the blade set at the same point (2h, 2e).

4. A sawing machine according to claim 2, c h a r a c t e r i z e d in that to the blade fixing means spaced apart from the means (4, 6, 8) moving the blade set in the frame (1) of the sawing machine is connected a spring means (30) known per se, the spring means being arranged to generate a reaction force to the inertia forces of the blade and the blade fixing arrangement by its spring force when the blade (2) is located at and in the vicinity of the dead point of the path on the side of the means (4, 6, 8) moving the blade set.

5. A sawing machine according to claim 1, c h a r a c t e r i z e d in that the spring means is preferably a cylinder (31) connected to the frame of the sawing machine and has a moving piston (32), the piston rod (33) of which is connected to the blade fixing means (2a-e).

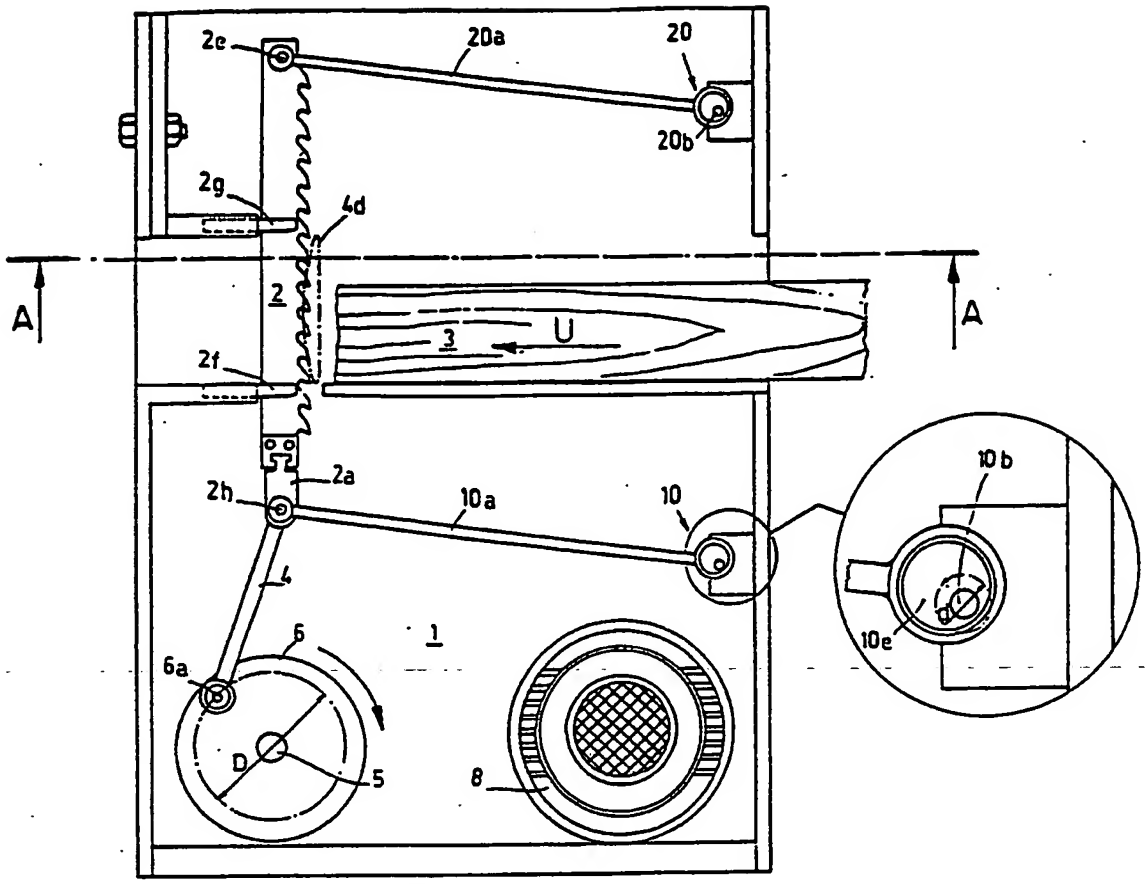

Fig. 1

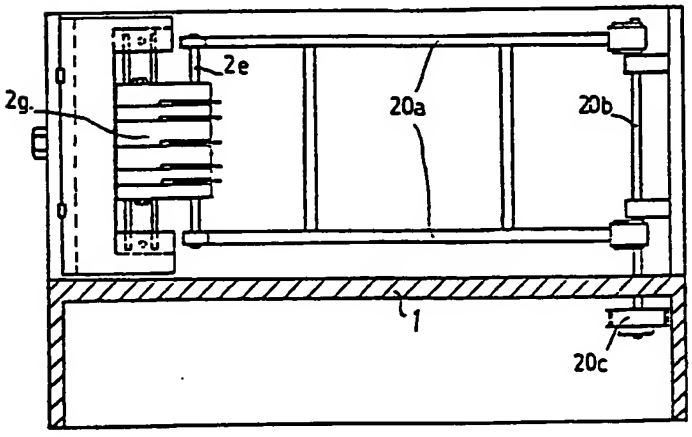

Fig. 3

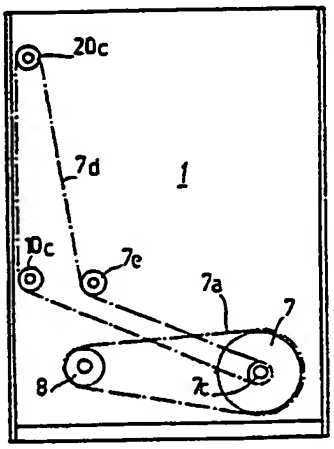

Fig. 2

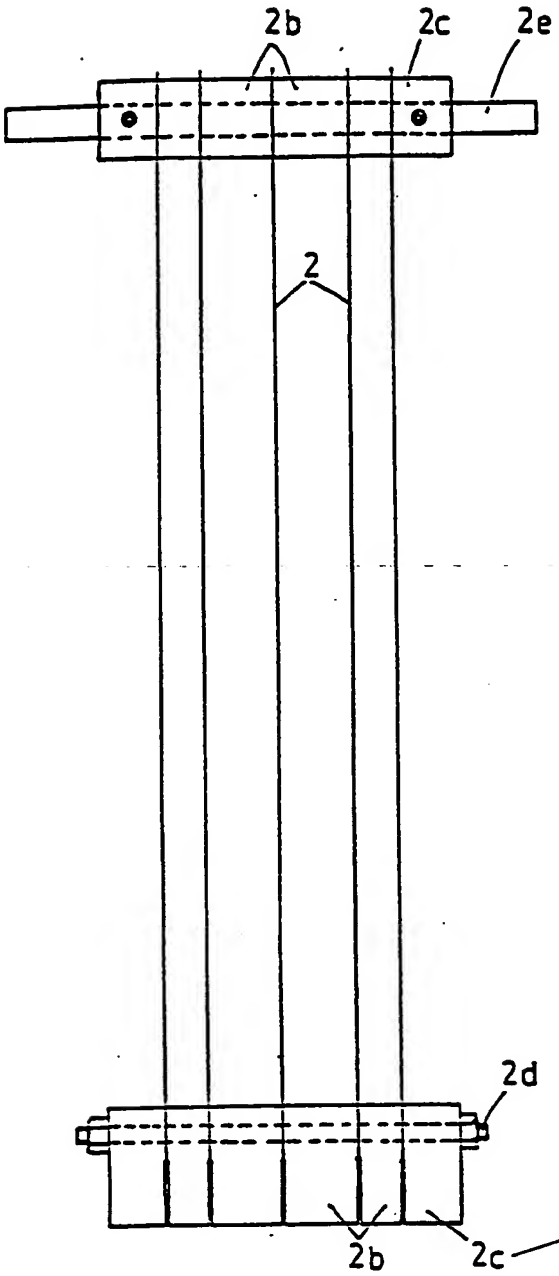

Fig. 4

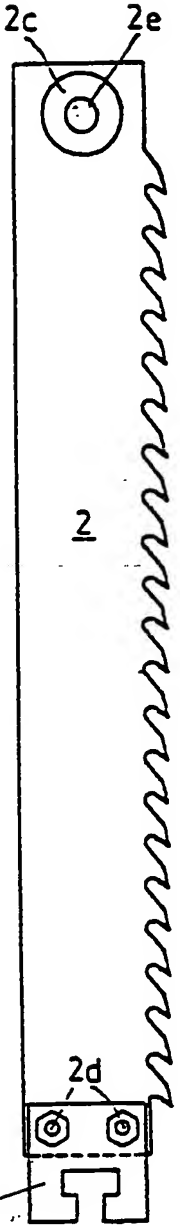

Fig. 5

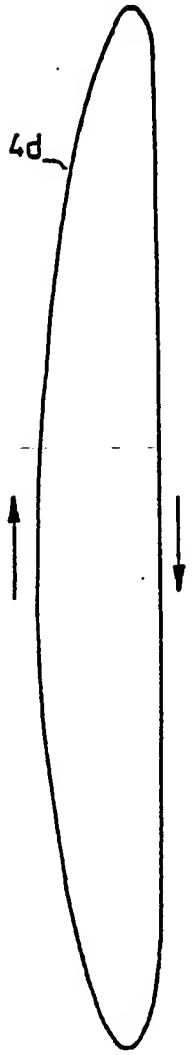

Fig. 6

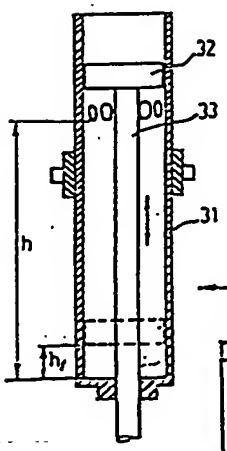

Fig. 8

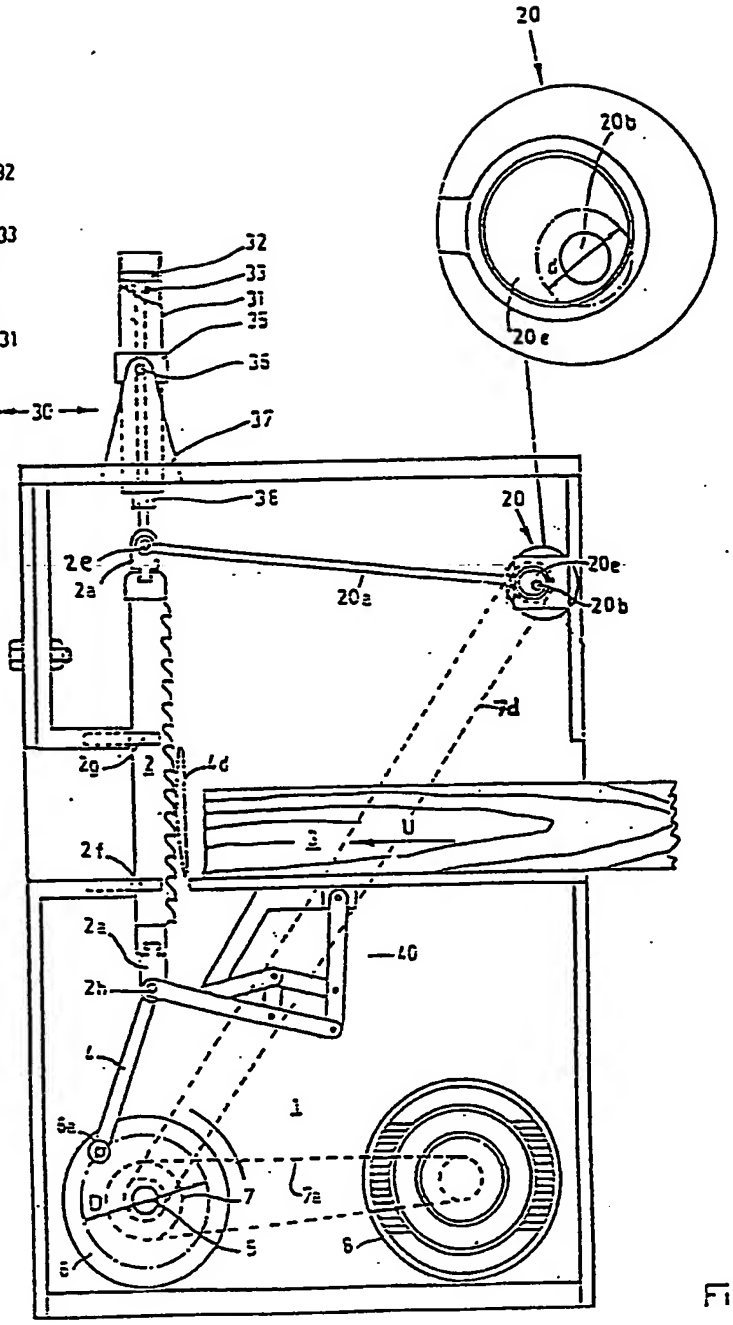

Fig.7

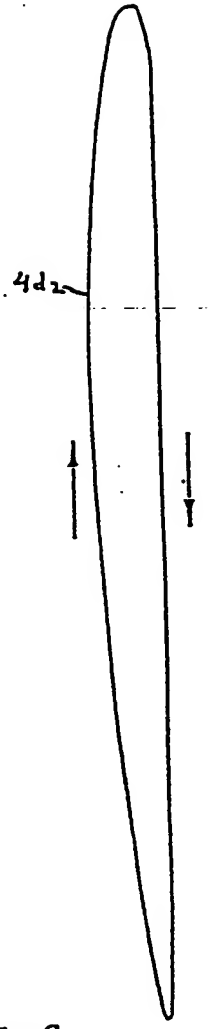

Fig. 9

INTERNATIONAL SEARCH REPORT

International application No.
PCT/FI 96/00269

A. CLASSIFICATION OF SUBJECT MATTER

IPC6: B27B 3/00
According to International Patent Classification (IPC) or to both national classification and IPC

B. FIELDS SEARCHED

Minimum documentation searched (classification system followed by classification symbols)

IPC6: B27B

Documentation searched other than minimum documentation to the extent that such documents are included in the fields searched

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QUESTEL: WPIL

C. DOCUMENTS CONSIDERED TO BE RELEVANT

Category*	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
X	SU 946925 A (TIMBER MECH SHAPING), 5 August 1982 (05.08.82), figures 1,2	1-3
Y	figures 1,2	4,5
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X	Derwent's abstract, No H4288 K/22, week 8322, ABSTRACT OF SU, 946925 (TIMBER MECH SHAPING), 5 August 1982 (05.08.82)	1-3
Y		4,5
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Y	GB 1240924 B (THOMAS ROBINSON & SONS LIMITED), 28 July 1971 (28.07.71)	4,5
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[X] Further documents are listed in the continuation of Box C. [X] See patent family annex.

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INTERNATIONAL SEARCH REPORT

International application No.
PCT/FI 96/00269

C (Continuation). DOCUMENTS CONSIDERED TO BE RELEVANT

Category*	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
Y	Derwent's abstract, No 94-116092/14, week 9414, ABSTRACT OF RU, 2004411 (ARKHAN FORESTRY INST), 15 December 1993 (15.12.93) --	4,5
Y	EP 0412958 A2 (COMTEC BITTER GESELLSCHAFT M.B.H.), 13 February 1991 (13.02.91) --	1-5
A	SE 464468 B (EERO KIVIMAA), 29 April 1991 (29.04.91) --	1-5

INTERNATIONAL SEARCH REPORT

Information on patent family members

31/07/96

International application No.
PCT/FI 96/00269

Patent document cited in search report	Publication date	Patent family member(s)	Publication date
SU-A- 946925	05/08/82	NONE	
GB-B- 1240924	28/07/71	NONE	
EP-A2- 0412958	13/02/91	NONE	
SE-B- 464468	29/04/91	SE-A- 8802954	24/02/90